Data Fusion for Sub-pixel Burn Detection with ARTMAP Neural Networks.
Future Plans.

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1. **Data Fusion for Sub-pixel Burn Detection with ARTMAP Neural Networks**

Introduction

- **Objectives of the Project**

  Develop AI based agent for detection of anomalies (such as burns, floods, deforestation etc, urbanization) in multidimensional satellite data.

- **Achievements**

  Implemented and tested ARTMAP based agent for robust burn detection in coarse resolution satellite data.
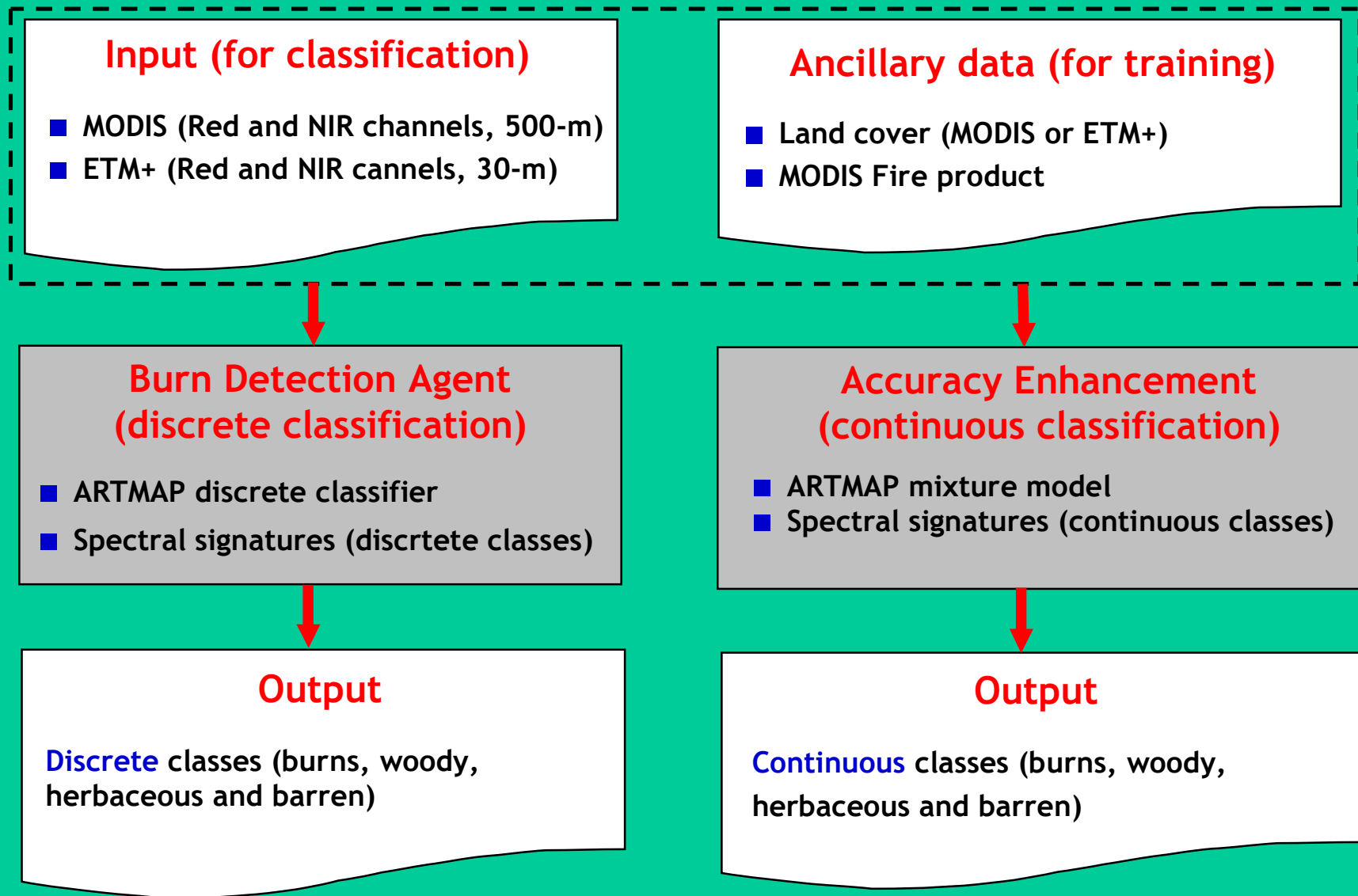
- **Data Fusion aspects**
  - Multiple data products at the same resolution (MODIS surface reflectances, land cover and fire products)
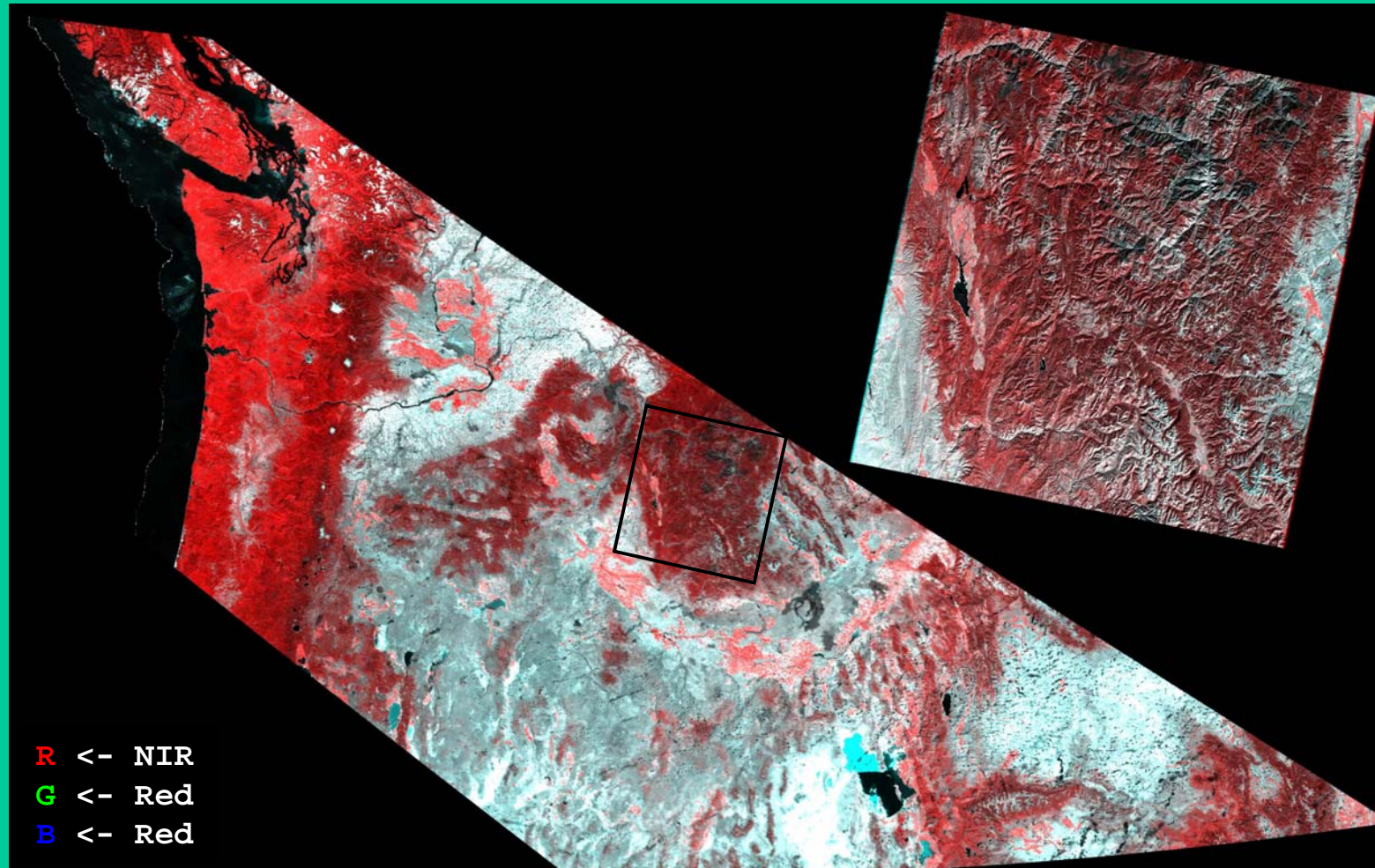 - Multiple resolution (MODIS, 500-m and ETM+, 30-m data)

- **System testing**
  - Study area: North-Western region of the US (Idaho and Montana States)
  - Burns after fire event during July-August 2000

System Design

Input (for classification)

- MODIS (Red and NIR channels, 500-m)
- ETM+ (Red and NIR cannels, 30-m)

Ancillary data (for training)

- Land cover (MODIS or ETM+)
- MODIS Fire product

Burn Detection Agent (discrete classification)

- ARTMAP discrete classifier
- Spectral signatures (discrtete classes)

Accuracy Enhancement (continuous classification)

- ARTMAP mixture model
- Spectral signatures (continuous classes)

Output

Discrete classes (burns, woody, herbaceous and barren)

Output

Continuous classes (burns, woody, herbaceous and barren)

ARTMAP Input: MODIS and ETM+ Surface Reflectances
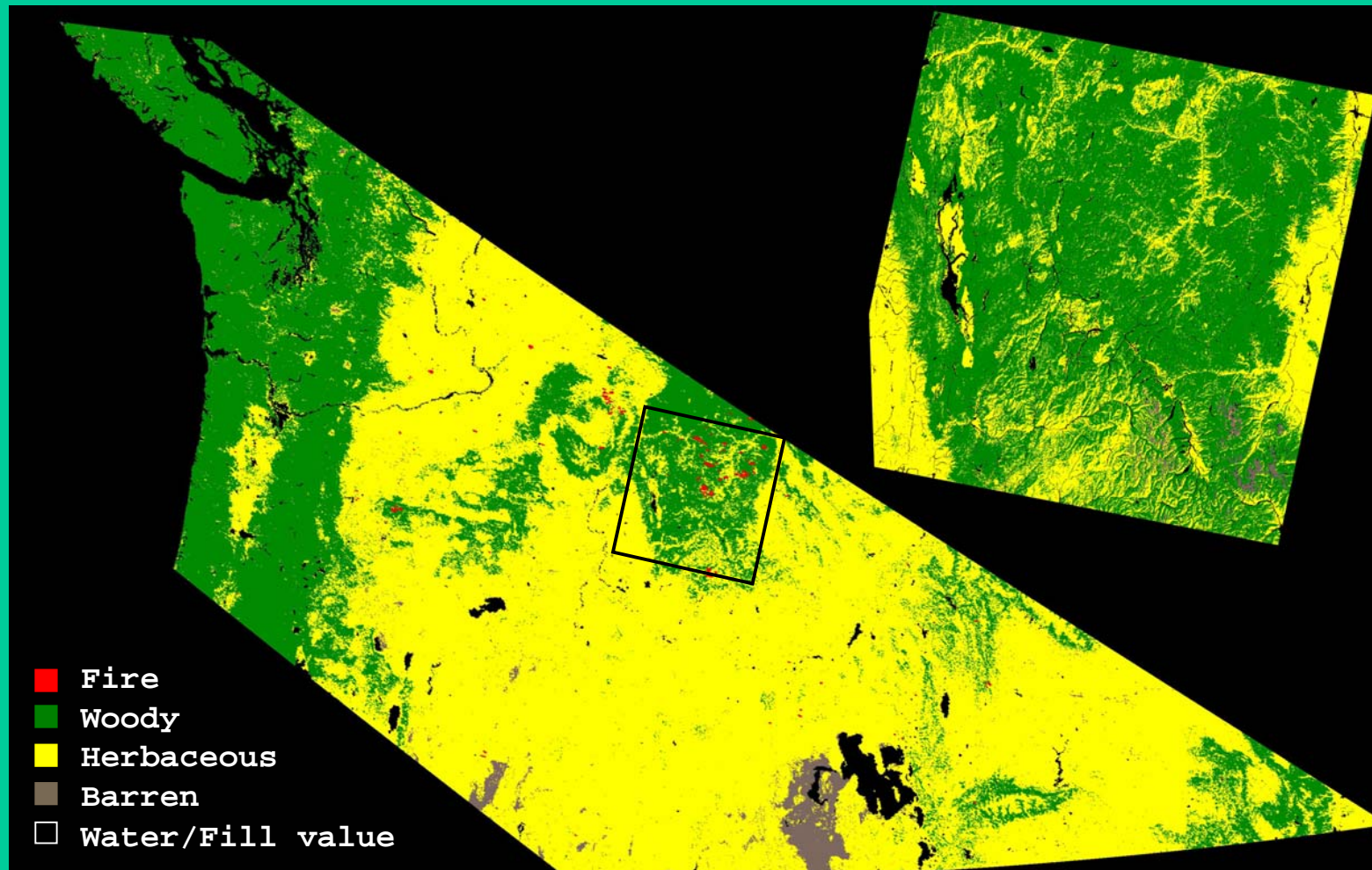

R <- NIR
G <- Red
B <- Red

MODIS SR (MOD09A1 product, v003, Red and NIR data, 500m, tile h09v04, Sept. 5-12, 2000)
ETM+ SR (Red and NIR data, 30 m, path 41 / row 29, Oct. 8, 2000)

Ancillary Data for ARTMAP Training:
MODIS and ETM+ Land Cover and MODIS Fire

Fire
Woody
Herbaceous
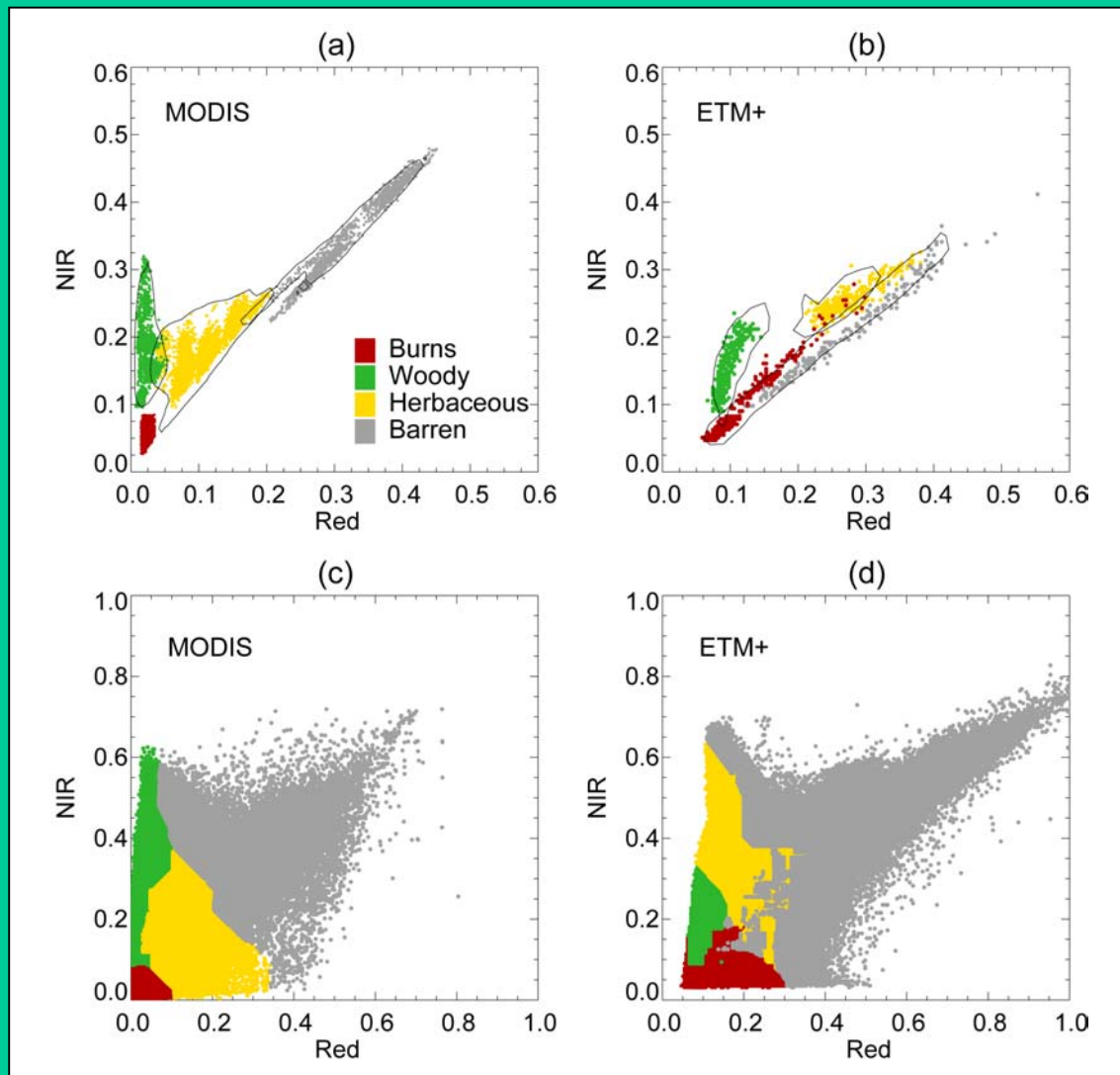**Barren**
Water/Fill value

MODIS LC (MOD12Q1 product, v003, IGBP crosswalked 3 life forms 1000m, tile h09v04)
MODIS Fire (MOD14A2 product, v003, Aug. 20-Sept. 12, 2000)
ETM+ LC (GAP land cover, 30 m, path 41 / row 29)

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ARTMAP Training: Signatures of Classes in RED-NIR Space

Legend:
- Burns (red)
- Woody (green)
- Herbaceous (yellow)
- Barren (gray)

- Burn detection is accomplished by ARTMAP classification of Earth into Burns + 3 vegetation life forms (Woody, Herbaceous and Barren) = 4 classes

- Training of ARTMAP is based on signatures of 4 classes in spectral space-predominant location of classes in RED-NIR spectral space (Figs. a, b)

- Given input surface reflectances and signatures of classes the classification is performed (Figs. c, d for RED-NIR decision space)
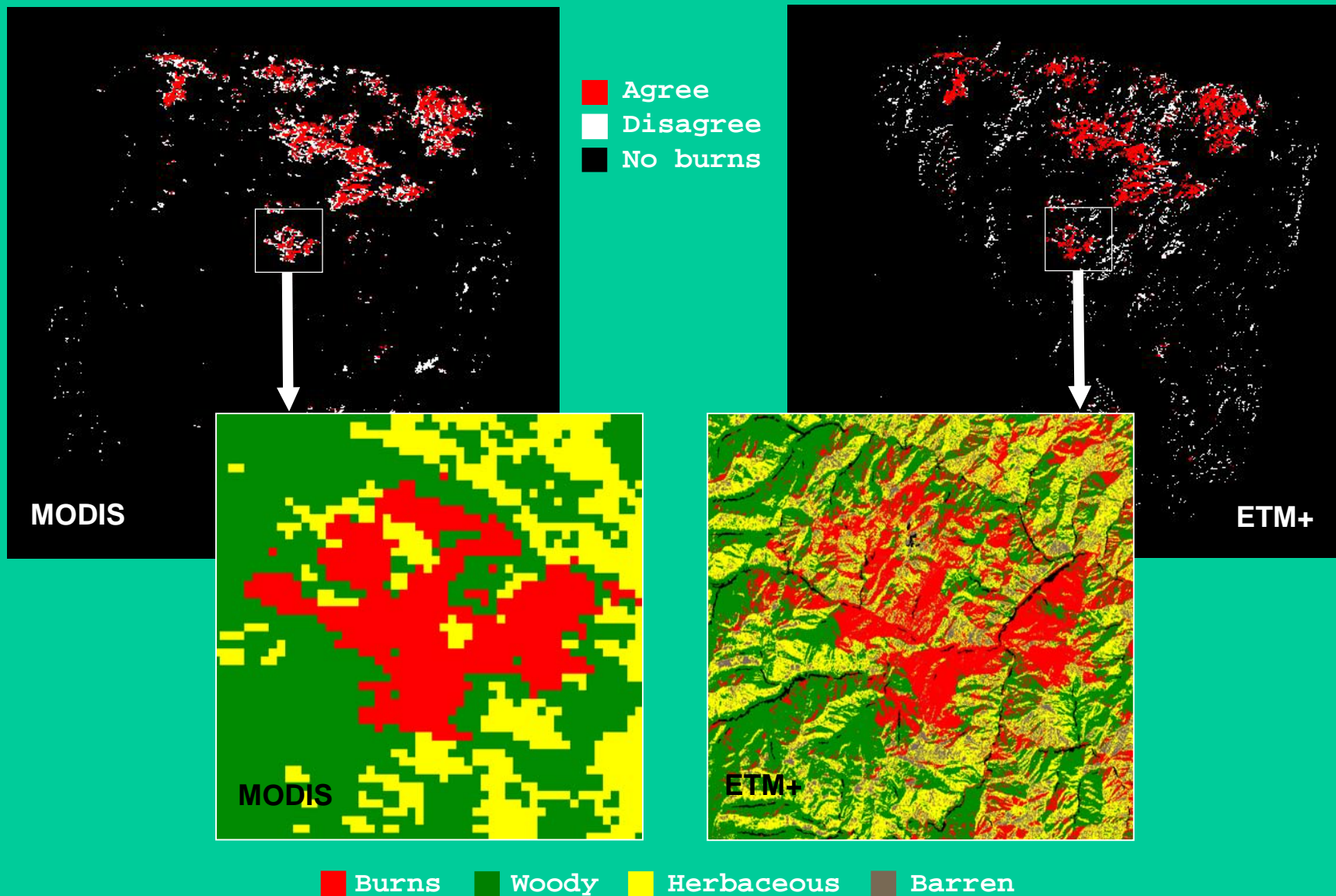
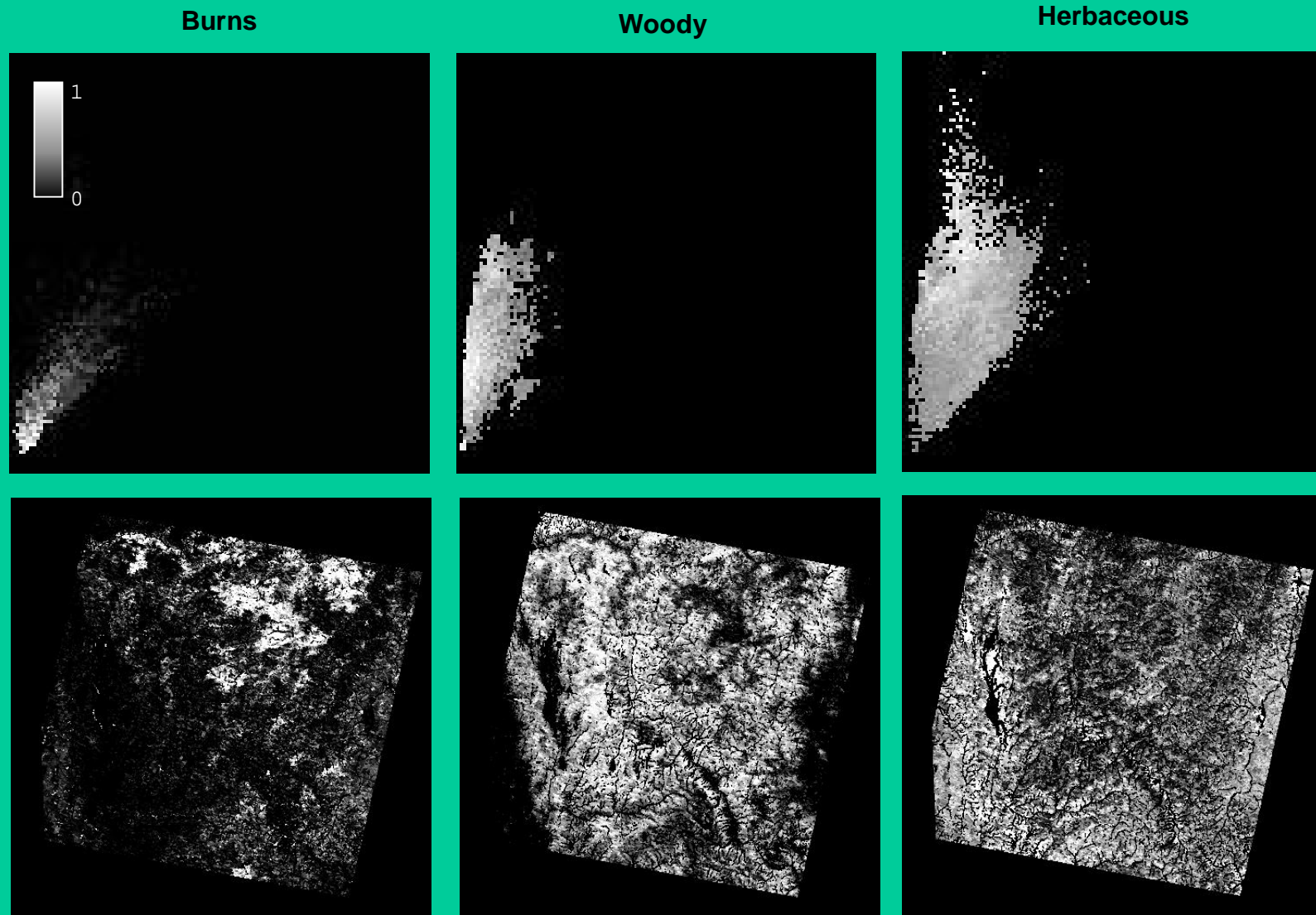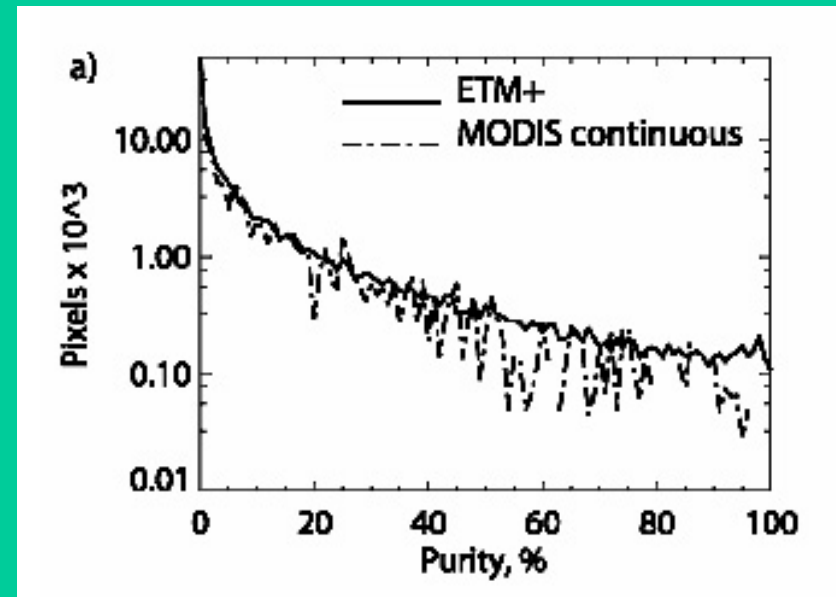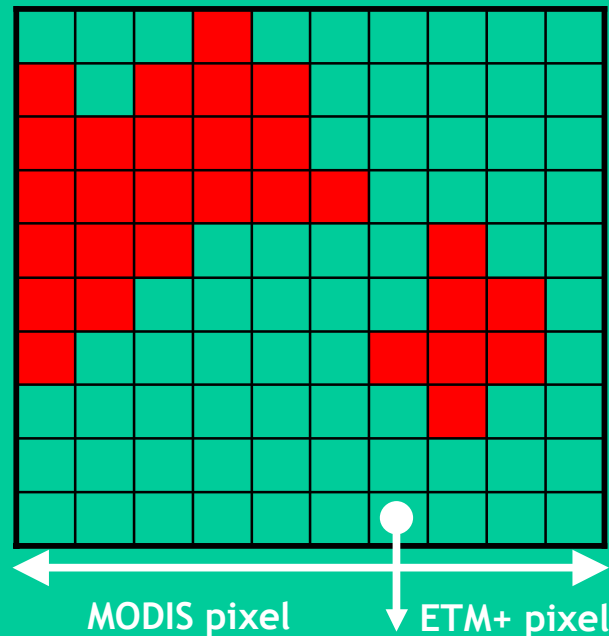# Discrete Classification of MODIS and ETM+ Data for Burn Detection

Burns
Woody
Herbaceous
Barren
Water/Fill value
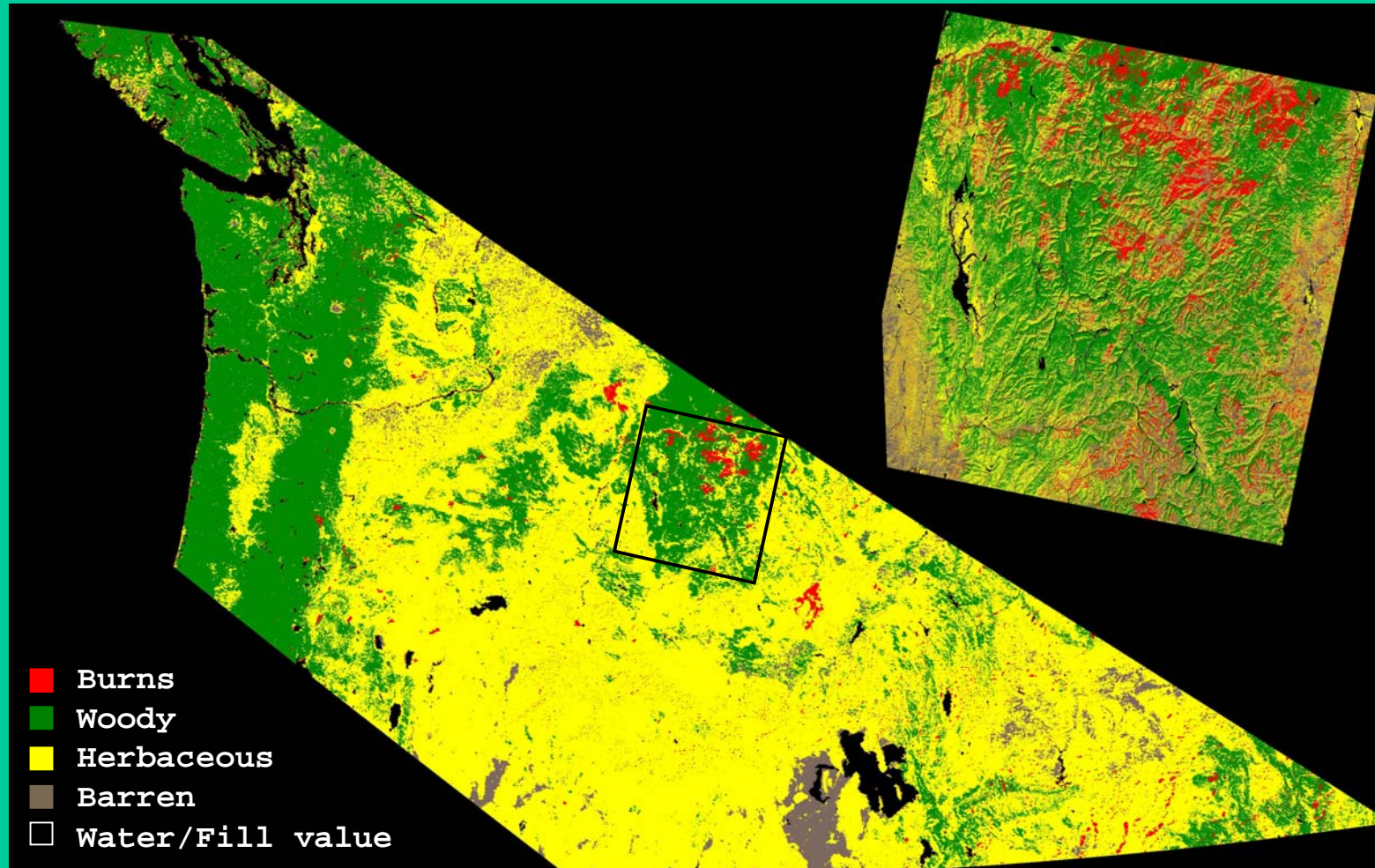
Comparison of the MODIS and ETM+ Discrete Classifications

Continuous Classification of MODIS Data for Burn Detection

Burns

Woody

Herbaceous

Comparison of MODIS Continuous and ETM+ Aggregated Discrete Classifications

MODIS pixel   ETM+ pixel

- Purity = (30-m Burns pixels) / (Total 30-m pixels in 500-m pixel)

- Comparison:
  - ETM+ discrete classification aggregated from 30-m to 500-m
  - MODIS continuous classification at 500-m

- ETM+ aggregated discrete classification shows similar statistical properties as MODIS continuous classification

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Accomplishments:

- Developed ARTMAP based agent for burn detection in coarse resolution satellite data. System was tested on MODIS 500-meters surface reflectance data

- Data fusion aspects of the project. Given multiple data sources (Surface reflectances, Land cover, Fire product) we extract information on burns, which is not a part of input data sources.

- Studied impact of land cover mixture on burn detection from coarse resolution data. Developed approach for continuous classification of burns (in contrast to discrete classification). Continuous classification results in more realistic burn mapping and accounts for partially burned pixels. This has important application for accurate measurements of burn area extend.

- Manuscript "Sub-pixel burn detection in MODIS 500-meters data with ARTMAP neural networks" by Shabanov et al., submitted for publication to RSE, Nov. 2003

2. Future plans

Distributed Data Mining for Modeling Co-variability in the Global Ecosystem

- **Goal of the Project**

  Implement a scalable distributed data mining system (DDMS) that analyzes data at distributed locations (DAACs) and labels images with codes and metrics relevant to Earth Scientists

- **Methods (Feature Extraction Algorithms)**
  - Distributed Image Grand Tour (for data volume reduction)
  - Collective Principal Component Analysis, CPCA (feature extraction)
  - Distributed Clustering using CPCA (distributed version of CPCA for feature extraction)

- **Earth Science objectives**
  - Explore utility of the DDMS for reliable monitoring of anomalous changes in vegetation productivity, with focus on croplands.
  - Evaluate trends and year-to-year variations in northern vegetation greennes, which is due to dominant modes of climate variability
  - Determine if correlation between northern vegetation greenness and temperature is valid at all spatial and temporal scales

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Earth Science Data for DDMS

Data Record	Instrument	Time Period	Resolution
Surface spectral Reflectances	MODIS	03/2000 to 12/2005	1 km & 8-day
Surface spectral Reflectances	AVHRR	07/1981 to 12/2005	8 km & 10-day
Vegetation Indices (NDVI)	MODIS	03/2000 to 12/2005	1 km & 8-day
Vegetation Indices	AVHRR	07/1981 to 12/2005	8 km & 10-day
Leaf Area Index (LAI)	MODIS	03/2000 to 12/2005	1 km & 8-day
Leaf Area Index (LAI)	AVHRR	07/1981 to 12/2005	8 km & 10-day
Fraction Absorbed PAR (FPAR)	MODIS	03/2000 to 12/2005	1 km & 8-day
Fraction Absorbed PAR (FPAR)	AVHRR	07/1981 to 12/2005	8 km & 10-day
Snow Cover	MODIS	03/2000 to 12/2005	500 m & 8-day
Northern Hemispher Snow Cover	Microwave sensors	10/1978 to 12/2005	25 km & 7-day
Land Cover Classification (LCC)	MODIS	N/A	1 km
GISS Land Surface Temperature	Station Data	01/1981 to 12/2005	2.5 deg & monthly
Precipitation	CMAP	01/1981 to 12/2005	2.5 deg & monthly
Sea Surface Temperature	NOAA	01/1981 to 12/2005	1 deg & monthly